APPENDIX A

CONCRETE REINFORCEMENT BAR SPOT WELD EVALUATION

1.0 INTRODUCTION

A unique spot welding process has been developed to be used when appropriate in lieu of ties between reinforcement bars being placed prior to pouring concrete. This evaluation was completed to qualify the process based on testing and analyses. The rebar spot welds were examined for strength and ductility. Furthermore, the effect of the welding on the reinforcement was examined to ensure the process does not degrade the material strength or ductility.

2.0 PLAN OF APPROACH

Specific issues of concern are the weld strength and ductility as well as quantification of the effect of the weld on the reinforcement. A test program was procedurized and testing completed to collect laboratory data appropriate for analyses and evaluation of the weld process suitability. The following evaluation summary memorializes the program results.

3.0 EVALUATION SUMMARY

The minimum failure load and rotational angle at failure are 120 pounds and 19°. This failure load is compatible with the material strength. All failure surfaces show ductility.

The welding process does not degrade the reinforcement strength. The weld and HAZ are stronger than the parent material and did not exhibit any non-ductile behavior.

4.0 TEST AND INSPECTION PROGRAM PROCEDURE

A total of eight specimens will be tested. Four of them shall be welded #4 bars and four welded #8 bars. The specimens shall be identified, photographed, and visually inspected prior to testing. The inspection results shall be recorded. It is necessary to note the weld locations and sizes as well as any weld defects such as undercut or lack of fusion.

Two twisting and two rolling bend tests shall be conducted for each specimen size as shown in the following figure. The specimens shall be rigidly restrained and loaded to failure. The maximal load applied as each specimen is broken shall be recorded in the

following load data summary table along with the rotation angle at maximal load application.

The broken specimens shall be photographed and visually inspected. The inspection results shall be recorded. Pretest inspection correlations comments must be made.

Specimen weld failure surfaces shall be photographed and the failure surface characteristics shall be noted to establish whether ductile or brittle failures occurred.

Specimen	Test condition	Failure Load (Pounds)	Rotational Angle at Failure (Degrees)
4-1	Twisting		
4-2	Twisting		
4-3	Rolling		
4-4	Rolling		
8-1	Rolling		
8-2	Twisting		
8-3	Twisting		
8-4	Rolling		

FAILURE LOAD TABULATION

One piece from each type of broken specimen shall be selected and sectioned through the broken weld so that microstructure and microhardness characteristics may be obtained in the weld, heat affected zone, and parent material. The specimens (4) shall be appropriately etched and photographed to show the metallurgical characteristics of the weld, heat affected zone, and parent material. Microhardnesses shall be recorded in the following data summary table. This same size (4) provides confidence that the complete weld population (16) does not contain different attributes.

The data required by this test program procedure shall be included as the following section of this evaluation.

Specimen	Weld (HRC)	HAZ (HRC)	Material (HRC)
4-1			
4-2			
4-3			
4-4			
8-1			
8-2			
8-3			
8-4			

MICROHARDNESS DATA SUMMARY

5.0 TEST AND INSPECTION PROGRAM RESULTS

A Failure Load Tabulation and Microhardness Data Summary follow:

Specimen	Test condition	Failure Load (Pounds)	Rotational Angle at Failure (Degrees)
4-1	Twisting	120	19
4-2	Twisting	200	28
4-3	Rolling	280	27
4-4	Rolling	210	28
8-1	Rolling	320	50
8-2	Twisting	615	36
8-3	Twisting	415	42
8-4	Rolling	505	35

FAILURE LOAD TABULATION

Specimen	Weld (HRC)	HAZ (HRC)	Material (HRC)
4-1	33.5	45.0	87.0
4-2	35.0	32.0	85.0
4-3	39.0	45.0	86.0
4-4	35.0	40.0	88.0
8-1	36.0	45.0	93.0
8-2	33.0	40.0	91.0
8-3	32.0	47.0	96.0
8-4	28.0	44.0	91.0

MICROHARDNESS DATA SUMMARY

Test and inspection program results follow on a specimen-by-specimen basis. Pretest specimen photographs and inspection comments are followed by equivalent posttest information. Maximal loads and deflections are summarized. Lastly, failure surface and material photomacrographs are provided with a microhardness data recapitulation.

The minimum failure load and rotations angle at failure are 120 pounds and 19°. All failure surfaces show ductility. The minimum ultimate parent material strength converted from HRB data is 81 ksi. The minimum HAZ and weld material ultimate strength converted from HRC data are 150 ksi and 134 ksi respectively. The weld and HAZ are stronger than the parent material and they did not exhibit any observed non-ductile behavior. Failure loads are compatible with the material strength.